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**WO 2004/007410 A1**

(54) Title: A PROCESS FOR THE PRODUCTION OF DIFLUOROMETHANE

(57) Abstract: A process for vapor phase fluorination of methylene chloride with anhydrous hydrogen fluoride (AHF) in the presence of a coprecipitated chromia-alumina impregnated with zinc salt as catalyst, removing (HCl) and heavier components by distillation, subjecting (HFC-32) rich cut to a further step of fluorination catalyst.

## A PROCESS FOR THE PRODUCTION OF DIFLUOROMETHANE

### FIELD OF THE INVENTION

5        This invention relates to a process for the preparation of difluoromethane (HFC-32) by vapor phase fluorination of methylene chloride with anhydrous hydrogen fluoride (AHF) using a coprecipitated chromia-alumina impregnated with a zinc salt as catalyst and purification of difluoromethane thus obtained, after removal of HCl and heavier components  
10    for enhancing the forward reaction of HCFC-31 to HFC-32, is passed over the fluorination catalyst in a second reactor to reduce the concentration of chlorofluoromethane (HCFC-31) by converting to pure HFC-32.

### BACKGROUND OF THE INVENTION

15        Hydrochlorofluorocarbons and Chlorofluorocarbons are used, extensively, as foam blowing agents, refrigerants, cleaning solvents and propellants for aerosol sprays. However, in the recent years there has been increasing international concern that chlorofluorocarbons may be damaging  
20    the earth's protective ozone layer, which helps in containing the UV rays coming to earth. To this effect an international legislation has been put in place to ensure that their manufacture/ use is phased out, completely. Extensive research work is being done to take care of the said concern and efforts are on to find suitable replacement(s) for chlorofluorocarbons. One  
25    such replacement could be fluorocarbons which do not contain chlorine, but which contain hydrogen.

      The hydrofluorocarbon difluoromethane (HFC-32) is of interest as a substitute by itself or in the form of a blend with other hydrofluoroalkanes like  
30    1,1,1,2-tetrafluoroethane (HFC-134a) and pentafluoroethane (HFC-125) for substituting ozone depleting HCFC's like chlorodifluoromethane (R-22) and R-502 in refrigeration, air-conditioning and other applications.

**PRIOR ART**

It is known in the art that the catalytic vapor phase fluorination of haloalkanes containing at least one halogen atom selected from chlorine or bromine in the molecule with hydrogen fluoride results in the formation of fluorine rich haloalkanes. In the early stages aluminium fluoride and chromium fluoride were found suitable as catalysts for vapour phase fluorination of haloalkanes.

One of the earliest patent, U.S. patent 2,744,148, disclosed a metal halide of elements selected from nickel, chromium, cobalt, copper or palladium carried on aluminium fluoride as catalyst for fluorination of methylene chloride. However, the yield of HFC-32 was only 15%. The use of an oxygenated chromium trifluoride disclosed in US 2745886 gave an yield of 35.7%.

The fluorination of methylene chloride to give HFC-32 involves two reaction steps. The first step is the exchange of one chlorine in dichloromethane by fluorine to give chrofluoromethane (HCFC-31). In the second step HCFC-31 is further fluorinated to give HFC-32. Both the steps referred above are reversible. All subsequent efforts were directed to the development of the fluorination catalyst that gave high conversion of methylene chloride with high selectivity of HFC-32.

UK patent GB 1307224 teaches the preparation of a chromium oxide catalyst for use in fluorination reaction. The examples carried out with methylene chloride and HF at 320°C gave a conversion of 51.7% and selectivity of 63.8% for HFC-32. The US patent 6337299 and 6300531 reports use of chromium oxide as a fluorination catalyst for methylene chloride conversion to HFC-32. A conversion of 62% and selectivity of 80% for HFC-32 was reported. The US pat. 5569795 utilising chromia based, US pat. 5900514 utilising bulk chromia, US pat. 6242659 utilising chromium oxide

with nickel and US pat. 5763704 utilising co-precipitated chromium oxide and Zinc as fluorination catalyst for the conversion of methylene chloride to HFC-32 is known. The highest conversion and selectivity of 99% and 93%, respectively were reported in US pat. 5763704 using Zn/Cr<sub>2</sub>O<sub>3</sub> catalyst.  
5 However this was achieved only when the mole ratio of HF to methylene chloride was as high as 27.

The US patent 5710353 reports the use of alumina or compounds of the element selected from Ti, V, Zr, Ge, Sn, Mo and Pb on alumina for the preparation of fluorination catalyst. This patent reports a very low conversion  
10 of 16.4% and a selectivity of 46.3% for HFC-32 using alumina alone. But the co-precipitated TiO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub> gave a conversion of 75.7% and selectivity of 82% at a high mole ratio of HF to methylene chloride of about 17.

EP Patent 0128510 reports the use of aluminium chloride or alumina or mixed halide of chromia and alumina or mixed oxides of chromia and alumina or ferric chloride on carbon to generate catalysts for the fluorination of methylene chloride to HFC-32. The highest conversion of methylene chloride reported was 93% with 82% selectivity for HFC-32.  
15

US patents 5155082 and 5763708 report the use of a mixed oxide catalyst comprising CrO<sub>3</sub>/Al<sub>2</sub>O<sub>3</sub> for the fluorination of methylene chloride to give HFC-32. The conversion and selectivity obtained was 82% and 89% in US 5763708. EP 0805136 discloses a fluorination catalyst prepared by  
20 chromium and nickel compounds on aluminium fluoride for the fluorination of methylene chloride to HFC-32 to obtain a 61% conversion of methylene chloride and selectivity of 96% for HFC-32.

A serious problem with the production of difluoromethane by the fluorination of dichloromethane is that a substantial amount of a highly toxic  
30 intermediate, chlorofluoromethane (HCFC 31), is produced as an impurity.

To address this impurity, the conventional distillation process is of little help despite the difference in relative volatility between HCFC-31 (b.p. -9.1 degree. C.) and HCFC-32 (b.p.: -51.7 degree C.) to bring down HCFC-31 below permissible limits.

5

European patent application EP 0508 630 describes a process for the contact of HFC-32 with an activated carbon to lower the HCFC-31 impurity in HFC-32. However, in the process, the selectivity is not very high and difluoromethane is adsorbed in the same proportions as HCFC-31, which in turn takes away the useful product as well as exhausts the capacity of the adsorbent at a faster rate than desired.

The use of molecular sieves for the purification of fluorohydrocarbons is known in the art. The purification treatments are usually performed at around ambient temperature. A process has been described in U.S. Pat. No. 5,608,129, to remove the traces of HCFC-31 present in HFC-32 by passing over a 13X molecular sieve at a temperature of at least 60 degree C.

An article by Rao, J.M. et al [See J.M. Rao et al Journal of Fluorine Chemistry 95 (1999) 177-180] teaches a process for preparing a catalyst based on co-precipitated chromia-alumina doped with zinc and/ or magnesium involving the steps of co-precipitating chromia and alumina, washing and drying, shaping and impregnation of zinc chloride. The article also explains the occurrence of dismutation reaction in catalytical vapor phase halogen exchange reaction, which was attributed to the presence of strong acid centres in the catalyst. PCT application no. WO 01/74483 also mentions coprecipitated catalyst promoted with zinc.

## SUMMARY OF THE INVENTION

The main object of the present invention is to provide a process for the preparation of difluoromethane and minimize the quantity of HCFC-31 in the product stream.

The coprecipitated chromia-alumina with zinc salt catalyst, when employed for the fluorination of methylene chloride, exhibited higher conversion and higher selectivity for HFC-32 under specific process conditions and also minimising formation of side products like methyl chloride and chloroform. The invention also embodies the reduction in the relative percentage of strong acid sites in the catalyst in order to achieve high selectivity.

The present invention relates to a process for the preparation of difluoromethane (HFC-32) by vapor phase fluorination of methylene chloride with anhydrous hydrogen fluoride (AHF) in the presence of a coprecipitated chromia-alumina impregnated with zinc salt as catalyst at a temperature ranging from 225 - 375°C, preferably 250 to 350°C, more preferably 260-325°C and contact time not exceeding 20 seconds, preferably between 4 to 10 seconds, removing HCl and heavier components by distillation, subjecting HFC 32 rich cut to a further step of fluorination in presence of fluorination catalyst to convert chlorofluoromethane (HCFC-31), an intermediate formed along with HFC-32, to HFC-32 thereby reducing the concentration of HCFC 31 in HFC-32 rich cut to obtain pure HFC-32

In another embodiment of the invention the molar ratio of methylene chloride anhydrous hydrogen fluoride is in the range of 1:2.1 to 1:15, preferably in the range of 1:2.5 to 1:6.

Further, according to the present invention, the intermediate HCFC-31 present as an impurity in HFC-32, coming out of the reaction section and after HCl and heavier components removal is converted to HFC-32 by passing

over fluorination catalyst in the second reactor to fluorinate HCFC-31 to HFC-32.

In another embodiment of the invention the highly toxic HCFC-31 is converted into the desired HFC-32 therein minimising the interaction of HCFC-31 with the environment substantially.

In another embodiment the heavier components comprising HCFC-31, unreacted methylene chloride and HF obtained after distillation of effluent stream coming out of the reactor is recycled back to the original feed.

#### **DETAILED DESCRIPTION OF THE INVENTION**

The present invention is to provide a process for the preparation of difluoromethane and minimize the quantity of HCFC-31 in the product stream. Further, this product stream is distilled to obtain an HFC-32 rich stream which contains HCFC-31 and HF. This stream is passed in the second reactor over a fluorination catalyst to get pure HFC-32.

The catalyst comprising a co-precipitated chromia alumina impregnated with a zinc salt, when employed for the fluorination of methylene chloride exhibited higher conversion and higher selectivity for HFC-32 and also minimising formation of side products like methyl chloride and chloroform. The said catalyst is used to convert the HCFC-31 present in the product stream to HFC-32.

The present invention relates to a process for the reaction of methylene chloride with anhydrous HF in the presence of said catalyst which provides higher conversion of methylene chloride with high selectivity for HFC-32 and also convert HCFC-31 present in the product stream to HFC-32.

The basic factors that influence the conversion of methylene chloride and selectivity for HFC-32 are :

- Reaction temperatures
- 5 • Mole ratio of methylene chloride to AHF
- The contact time for reaction
- The characteristics of the precatalyst
- The activation of precatalyst with HF.

10 The co-precipitated chromia alumina catalyst contain chromium-aluminium in the atomic ratio 1:1 to 1: 10 and the amount of zinc compound used for impregnation of co-precipitated Chromia/Alumina catalyst ranges from 3-11% by weight. The catalyst should be X-ray amorphous and should contain the alumina in gamma phase and the chromia as chromium oxide  
15 trihydrate. The oxidation state of Cr should preferably be Cr (III) and the wt. % of Cr (VI) should be in the range 0 – 2% of the total chromium present in the said catalyst.

The fluorination reaction is carried out at a temperature in the range of  
20 225 – 375°C. The reaction temperature should preferably be in the range 250 – 350°C and more preferably between 260 – 325°C.

The fluorination of methylene chloride with AHF using the co-precipitated chromia-alumina with zinc salt as catalyst to give HFC-32 could  
25 be carried out at pressures in the range from sub-atmospheric to superatmospheric pressures. The fluorination using the catalyst under the above mentioned temperature conditions is carried out at superatmospheric pressures.

30 The stoichiometric ratios for the fluorination of methylene chloride with HF is 1 : 2. However, excess of HF contributes to higher conversions and also extends the life of the said catalyst. The present invention uses excess of



AHF and the mol. ratio of methylene chloride to AHF is in the range of 1 : 2.1 to 1: 15, preferably, in the range 1 : 2.5 to 1 : 6 .

5 The contact time for the fluorination of methylene chloride using AHF and the coprecipitated chromia alumina with zinc salt as catalyst is in the range 3 – 20 seconds, preferably, in the range of 4 – 10 seconds.

10 The catalytic activity in the halogen exchange has been attributed to the Lewis acid centers. In the case of chromia based catalyst the activity was attributed to the number of reversibly oxidizable sites in the precatalyst. In the alumina based catalyst the formation of  $AlF_3$  in the beta and gamma phase during activation is critical to the catalytical activity. The activation of precatalyst is carried out under controlled conditions preventing the formation of alpha aluminium fluoride and the amorphous nature of the catalyst is  
15 maintained.

The catalyst was calcined and further activated by treating sequentially with  $N_2$  at  $400^\circ C$  for 24 hours followed by fluorination in the temperature range  $150^\circ$  to  $400^\circ C$  till the exit stream of HF contains less than 1% of  
20 moisture.

The production of HFC-32 is carried out by reacting methylene chloride and HF in the presence of a co-precipitated chromia-alumina promoted with zinc salt. The effluent stream coming out of the fluorination reactor comprising  
25 of HFC-32, HCl, HCFC-31, unreacted methylene chloride and HF is sent to a second reactor. The separation and purification of HFC-32 is done in a phased manner using a series of distillations/ condensations.

30 In another embodiment of the invention HFC-32 is purified by reacting HCFC-31, an intermediate and present as an impurity, with HF in the presence of the said catalyst. The present invention utilises the principle of

enhancing the forward reaction by selectively removing one of the products formed, which in the present invention is HCl.

The present invention embodies the advantages of converting the highly toxic HCFC-31 into the desired HFC-32 therein minimising the interaction of HCFC-31 with the environment substantially.

A more complete appreciation of the invention and the attendant advantages thereof will be more clearly understood by reference to the accompanying drawings, which are for illustrative purposes, hence the same should not be construed to restrict the scope of the invention.

#### DESCRIPTION OF THE DRAWINGS

FIG. 1, is a flow sheet illustrating one embodiment of the present invention. The embodiment comprises reacting methylene chloride, process stream 2 with AHF, process stream 1 in a reactor, Reactor I to form HFC-32. The effluent stream from the reactor, process stream 3 is fed into a distillation column, Dist I to give distillate as HCl, process stream 4, and a side-cut fraction, process stream 6, containing HFC-32 as a distillate with small amounts of HCFC-31 and azeotropic HF. The process stream 6 is sent to further processing which comprises of a second reactor, Reactor II comprising a fluorination catalyst bed and the effluents of the second reactor, process stream 7 are neutralised and dried from which pure HFC-32 is recovered. The bottom process stream from Dist I, process stream 5, containing HCFC-31 and unreacted methylene chloride and HF is recycled back to the original feed stream, combined stream of process stream 1 and 2.

FIG. 2, is a flow sheet illustrating another embodiment in which side stream withdrawal is not employed and one additional distillation column is used. In the flow sheet illustrated in fig. 2, feed comprising of methylene chloride, process stream 2 with AHF, process stream 1 is fed into a reactor,

Reactor I to form HFC-32. The effluent stream from the reactor, process stream 3 is fed into first distillation column, Dist I to give distillate as HCl, process stream 4 and the bottom process stream 8 is fed into another distillation column, Dist II. The distillate, process stream 6 from Dist II contains HFC-32 as a main component and small amounts of HCFC-31 and azeotropic HF. The process stream 6 is sent to a second reactor, Reactor II comprising a fluorination catalyst bed. The effluents of the second reactor, process stream 7 are neutralised and dried from which pure HFC-32 is recovered. The bottom process stream from Dist II, process stream 5, containing HCFC-31 and unreacted methylene chloride and HF is recycled back to the original feed stream, combined stream of process stream 1 and 2.

FIG. 3 is a flow sheet illustrating another embodiment in which feed comprising of methylene chloride, process stream 2 with AHF, process stream 1 is fed into a reactor, Reactor I to form HFC-32. The effluent stream from the reactor, process stream 3 is fed into first distillation column, Dist I to give distillate as HFC-32, HCl, HCFC-31 and azeotropic HF, process stream 8 and the bottom process stream 8 is fed into another distillation column, Dist II. The distillate, process stream 4 from Dist II contains HCl. The bottom of Dist II gives a process stream 6 having HFC-32 as a main component and small amounts of HCFC-31 and azeotropic HF. The process stream 6 is sent to a second reactor, Reactor II comprising a fluorination catalyst bed. The effluents of the second reactor, process stream 7 are neutralised and dried from which pure HFC-32 is recovered. The bottom process stream from Dist I, process stream 5, containing HCFC-31 and unreacted methylene chloride and HF is recycled back to the original feed stream, combined stream of process stream 1 and 2

The present invention is illustrated in more detail below by reference to the following non-limiting examples. Preferred conditions are not necessarily used in the examples, which are intended to show the effect of varying the process conditions such as feed quantities, temperature, etc.

**EXAMPLES:****EXAMPLE 1****Fluorination of methylene chloride**

5

450 ml of the catalyst comprising co-precipitated chromia-alumina impregnated with zinc chloride (chemical composition – Cr : Al : Zn – 22 : 75 : 3) was packed into an electrically heated Inconel tubular reactor provided with multiple temperature sensing points. The catalyst was pre-treated by passing  
10 N<sub>2</sub> at about 400°C for 24 hrs. The temperature of the catalyst bed was lowered to 100°C and AHF was introduced along with N<sub>2</sub>. The highly exothermic reaction occurring is controlled by adjusting the flowrates of N<sub>2</sub> and AHF and the temperature of the catalyst bed is not allowed to exceed 400°C. As the fluorination proceeds, N<sub>2</sub> is withdrawn and pure AHF was  
15 passed while simultaneously raising the temperature to 350°C. The activation of the catalyst is completed when the moisture content in the exit stream of AHF becomes less than 1%.

20

Then the temperature of the catalyst bed is brought to 275°C after which the fluorination of methylene chloride with AHF was carried out by co-feeding the reactants comprising a mixture of methylene chloride 60 gm/h and HF 62 gm/h in vapor form over the activated catalyst. The effluent stream from the catalyst bed was scrubbed in KOH solution in a scrubber and then passed through a molecular sieve drier and condensed in a trap cooled  
25 in a dry ice-acetone bath.

30

The samples of the product stream were drawn after freeing from acidic components and drying and analyzed by GC and was found to be (by wt.) HFC-32 88.67 %, HCFC-31 7.79% and methylene chloride 3.31%  
(Conversion of methylene chloride – 96.5% and selectivity for HFC-32 – 91.9%)

## EXAMPLE 2

### Fluorination of methylene chloride

450 ml of the catalyst comprising co-precipitated chromia-alumina  
5 impregnated with zinc chloride (chemical composition – Cr : Al : Zn – 22 : 75 :  
3) was packed into an electrically heated Inconel tubular reactor provided with  
multiple temperature sensing points. The catalyst was pre-treated by passing  
N<sub>2</sub> at about 400°C for 24 hrs. The temperature of the catalyst bed was  
lowered to 100°C and AHF was introduced along with N<sub>2</sub>. The highly  
10 exothermic reaction occurring is controlled by adjusting the flowrates of N<sub>2</sub>  
and AHF and the temperature of the catalyst bed is not allowed to exceed  
400°C. As the fluorination proceeds, N<sub>2</sub> is withdrawn and pure AHF was  
passed while simultaneously raising the temperature to 350°C. The activation  
of the catalyst is completed when the moisture content in the exit stream of  
15 AHF becomes less than 1%.

Then the temperature of the catalyst bed is brought to 275°C after  
which the fluorination of methylene chloride with AHF was carried out by co-  
feeding the reactants comprising a mixture of methylene chloride 87 gm/h  
20 and HF 79.5 gm/h over the activated catalyst. The effluent stream from the  
catalyst bed was scrubbed in KOH solution in a scrubber and then passed  
through a molecular sieve drier and condensed in a trap cooled in a dry ice-  
acetone bath.

25 The samples of the product stream were drawn after freeing from  
acidic components and drying and analyzed by GC and was found to be (by  
wt.) HFC-32 85.95 %, HCFC-31 8.7% and methylene chloride 5.27%  
(Conversion of methylene chloride – 94.73% and selectivity for HFC-32 –  
90.7%)

30

## EXAMPLE 3

### Fluorination of methylene chloride

450 ml of the catalyst comprising co-precipitated chromia-alumina impregnated with zinc chloride (chemical composition – Cr : Al : Zn – 22 : 75 : 3) was packed into an electrically heated Inconel tubular reactor provided with multiple temperature sensing points. The catalyst was pre-treated by passing N<sub>2</sub> at about 400°C for 24 hrs. The temperature of the catalyst bed was lowered to 100°C and AHF was introduced along with N<sub>2</sub>. The highly exothermic reaction occurring is controlled by adjusting the flowrates of N<sub>2</sub> and AHF and the temperature of the catalyst bed is not allowed to exceed 400°C. As the fluorination proceeds, N<sub>2</sub> is withdrawn and pure AHF was passed while simultaneously raising the temperature to 350°C. The activation of the catalyst is completed when the moisture content in the exit stream of AHF becomes less than 1%.

Then the temperature of the catalyst bed is brought to 250°C after which the fluorination of methylene chloride with AHF was carried out by co-feeding the reactants comprising a mixture of methylene chloride 40 gm/h and HF 40 gm/h over the activated catalyst. The effluent stream from the catalyst bed was scrubbed in KOH solution in a scrubber and then passed through a molecular sieve drier and condensed in a trap cooled in a dry ice-acetone bath.

----- The samples of the product stream were drawn after freeing from acidic components and drying and analyzed by GC and was found to be (by wt.) HFC-32 79.6 %, HCFC-31 8.5% and methylene chloride 11.9% (Conversion of methylene chloride – 88.1% and selectivity for HFC-32 – 90.3%)

#### EXAMPLE 4

Purification of HFC – 32

Impure HFC-32 comprising a mixture of HFC-32 98 gm, HCFC-31 100 ppm and HF 2 gm is obtained after removal of HCl and heavier components (by any of the processes defined - fig. 1, 2 or 3) from the outlet stream of reactor. The mixture was fed into the reactor at 275°C with a contact time of 12 seconds. The reactor outlet was analyzed at the sampling point for R 31 and was found to be 1 ppm.

#### **EXAMPLE 5**

##### **Purification of HFC – 32**

10

Impure HFC-32 comprising a mixture of HFC-32 98 gm, HCFC-31 100 ppm and HF 2 gm is obtained after removal of HCl and heavier components (by any of the processes defined - Fig. 1, 2 or 3) from the outlet stream of reactor. The mixture was fed into the reactor at 275°C with a contact time of 6 seconds. The reactor outlet was analyzed at the sampling point for R 31 and was found to be 20 ppm.

#### **EXAMPLE 6**

##### **Purification of HFC – 32**

20

Impure HFC-32 comprising a mixture of HFC-32 98 gm, HCFC-31 100 ppm and HF 2 gm is obtained after removal of HCl and heavier components (by any of the processes defined - fig. 1, 2 or 3) from the outlet stream of reactor. The mixture was fed into the reactor at 250°C with a contact time of 9 seconds. The reactor outlet was analyzed at the sampling point for R 31 and was found to be 22 ppm.

#### **EXAMPLE 7**

##### **Purification of HFC – 32**

30

Impure HFC-32 comprising a mixture of HFC-32 98 gm, HCFC-31 500 ppm and HF 2 gm is obtained after removal of HCl and heavier components

(by any of the processes defined - fig. 1, 2 or 3) from the outlet stream of reactor. The mixture was fed into the reactor at 290°C with a contact time of 7 seconds. The reactor outlet was analyzed at the sampling point for R 31 and was found to be 56 ppm.

5

### EXAMPLE 8

#### Purification of HFC - 32

Impure HFC-32 comprising a mixture of HFC-32 90 gm, HCFC-31 500 ppm and HF 10 gm is obtained after removal of HCl and heavier components (by any of the processes defined - fig. 1, 2 or 3) from the outlet stream of reactor. The mixture was fed into the reactor at 290°C with a contact time of 9 seconds. The reactor outlet was analyzed at the sampling point for R 31 and was found to be 1 ppm.

15

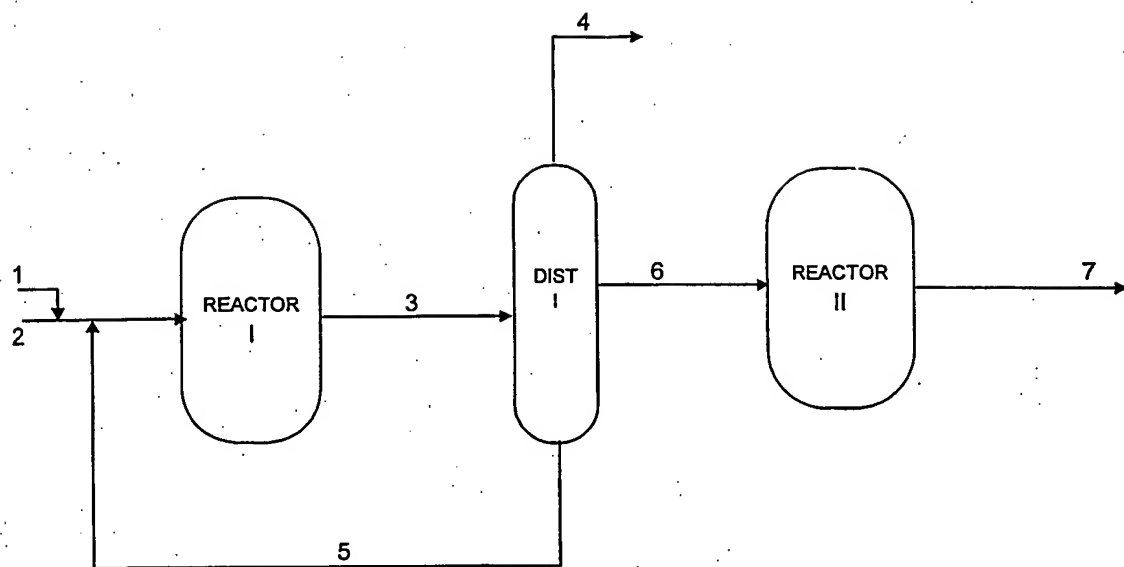
While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

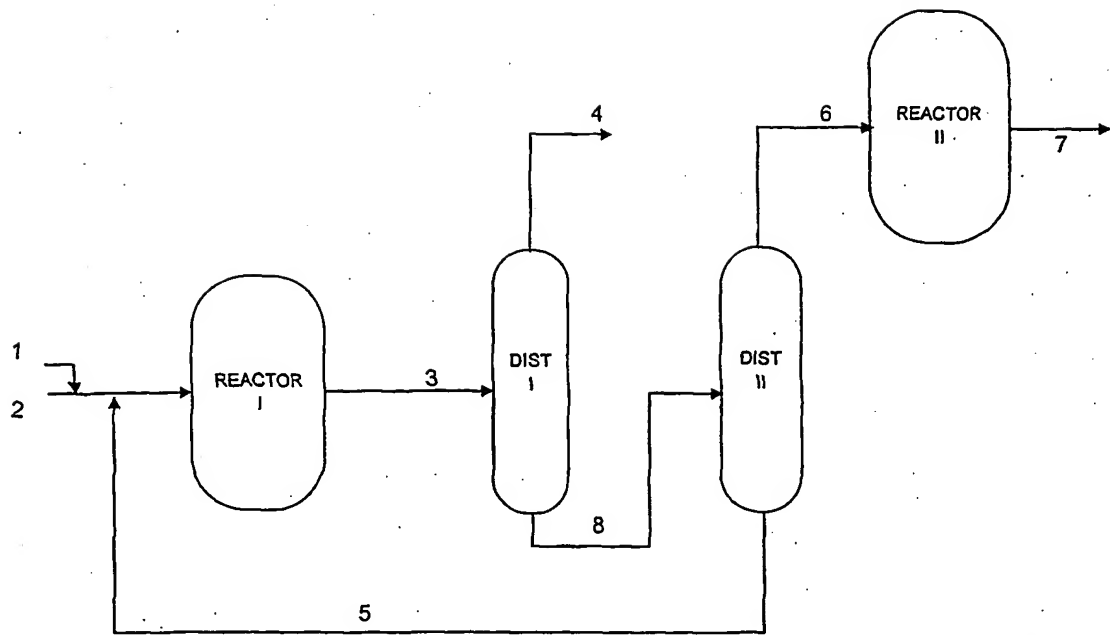
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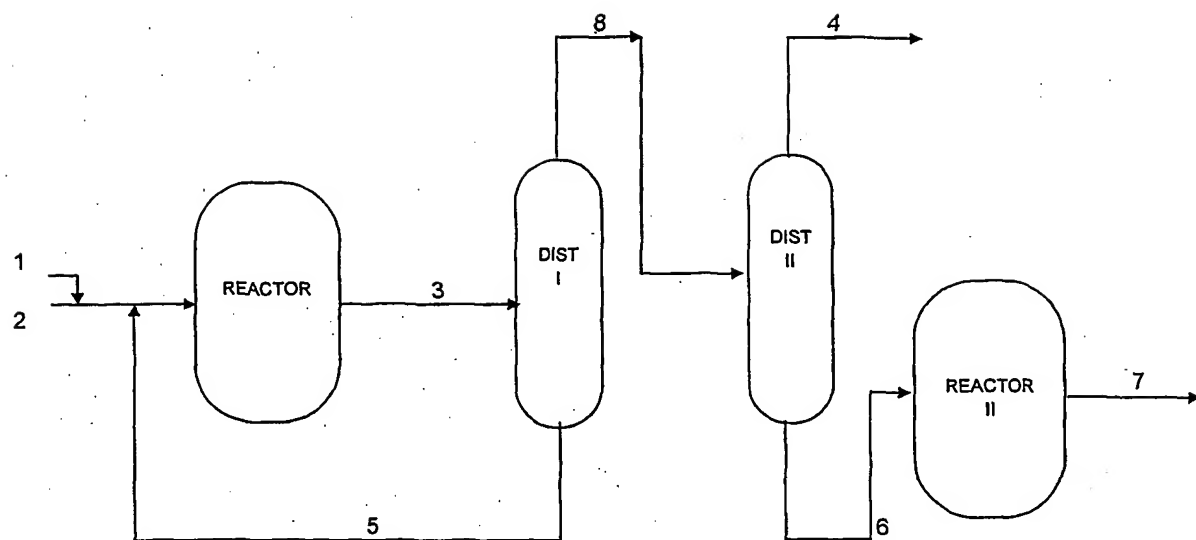


### CLAIMS

1. A process for the preparation of difluoromethane (HFC-32) by vapor phase fluorination of methylene chloride with anhydrous hydrogen fluoride (AHF) in the presence of a coprecipitated chromia-alumina impregnated with zinc salt as catalyst at a temperature ranging from 225 - 375°C and contact  
5 time not exceeding 20 seconds, removing HCl and heavier components by distillation, subjecting HFC-32 rich cut to a further step of fluorination in presence of fluorination catalyst to convert chlorofluoromethane HCFC-31, an intermediate formed along with HFC - 32, to HFC-32 thereby reducing  
10 the concentration of HCFC 31 in HFC-32 rich cut to obtain pure HFC-32.
2. A process as claimed in claim 1, wherein the molar ratio of methylene chloride to anhydrous hydrogen fluoride is in the range of 1:2.1 to 1:15, preferably in the range of 1:2.5 to 1:6.
3. A process as claimed in claim 1, wherein the reaction is carried out at a  
15 temperature ranging from 250 to 350°C, preferably ranging from 260 to 325°C.
4. A process as claimed in claim 1, wherein the heavier components are recycled back to the original feed stream.
5. A process as claimed in claim 1, wherein the fluorination catalyst is  
20 coprecipitated chromia-alumina impregnated with zinc salt.
6. A process as claimed in claim 5, wherein the weight % of the zinc compound based on the weight of the catalyst ranges from 3-11%.
7. A process as claimed in claim 1, wherein the contact time for the fluorination of methylene chloride using AHF and the said catalyst could be in  
25 the range 3-20 seconds, preferably in the range of 4-10 seconds.

**FIG. 1**

**FIG. 2**

**FIG. 3**

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IN02/90148

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :C07C 21/18, 17/00, 19/08, 17/08

US CL :570/136, 161, 165, 166

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 570/136, 161, 165, 166

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST TEXT; STN TEXT

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,763,704 (SCOTT ET AL.) 09 JUNE 1998, ENTIRE PATENT.	1-7
Y	US 5,763,708 A (CLEMMER ET AL.) 09 JUNE 1998. ENTIRE PATENT	1-7
Y	US 5,900,514 A (REQUIEME ET AL.) 04 MAY 1999, ENTIRE PATENT.	1-7
Y	US 6,242,659 B1 (REQUIEME ET AL.) 05 JUNE 2001, ENTIRE PATENT.	1-7
Y	US 2,744,148 A (RUH ET AL.) 01 MAY 1956, ENTIRE PATENT.	1-7
Y	US 2,745,886 A (RUH ET AL.) 15 MAY 1956, ENTIRE PATENT.	1-7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:		"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

10 MARCH 2003

Date of mailing of the international search report

21 APR 2003

Name and mailing address of the ISA/US  
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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IN02/00148

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,569,795 A (TSUJI ET AL.) 29 OCTOBER 1996, ENTIRE PATENT.	1-7
Y	US 5,710,353 A (SHIBANUMA ET AL.) 20 JANUARY 1998, ENTIRE PATENT.	1-7
Y	US 5,155,082 A (TUNG ET AL.) 13 OCTOBER 1992, ENTIRE PATENT.	1-7